Distribution and Abundance of Dall's Sheep in the Richardson Mountains, June 2001

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ABSTRACT

Aerial block surveys were conducted during 20 to 25 June 2001 to document the number and distribution of Dall's sheep (*Ovis dalli*) in the Richardson Mountains, Northwest Territories (NWT) and Yukon Territory (YT).

We counted and classified 1,057 sheep including 734 nursery sheep, 92 lambs, 231 rams (43 half curl, 55 three-quarter curl and 133 full curl). The annual rate for the non-lamb portion of the population was 8% during 1997 to 2001; this was the first decline documented for this sheep population since surveys began in 1984. The number of full curl rams decreased by 38% (from 373 in 1991 to 231 in 2001). There were 12.5 lambs per 100 nursery sheep; this ratio was significantly lower than those observed during surveys conducted in 1984 to 1997. Little recruitment can be expected in 2002 indicating that further declines in the population can be expected. The majority of lambs, nursery sheep, and rams were found in the NWT; the majority of rams were found in the Rat block. Overall 66% of the sheep observed were found in the NWT.

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INTRODUCTION

The Dall's sheep in the Richardson Mountains are part of an island population at the northernmost extent of their distribution in Canada (Barichello et al. 1987). These sheep and those in the British Mountains, Yukon Territory (YT), are the only populations in Canada that inhabit ranges north of the Arctic Circle and are exposed to rigorous Arctic environments (Barichello et al. 1987). The Richardson Mountains Dall's sheep population is largely unhunted. Gwich'in and Inuvialuit harvest a small number of sheep, primarily ewes and lambs, each year. Some residents of Aklavik have expressed an interest in conducting guided sheep hunts for non-resident hunters since the late 1980s. The Gwich'in Renewable Resources Board (GRRB), the Department of Environment and Natural Resources (ENR), GNWT, and the Department of Environment, Yukon Territorial Government, currently survey this population every three to five years to monitor population trends and productivity.

A number of surveys of this population were conducted by biologists between 1971 and 1986 (Simmons 1973, Hoffman 1974, Nolan and Kelsall 1977, Hoefs 1978, Males 1980, Latour 1984). Population estimates obtained during these surveys suggested that the population had declined from 447 in 1972 (Nolan and Kelsall 1977) to 68 in 1983 (Latour 1984). Barichello et al. (1987) estimated that there were 543 sheep in the area in 1984. As a result, the suspected decline in sheep numbers between 1972 and 1983 may have been a function of survey methods or area surveyed, or both. Barichello et al. (1987) re-surveyed the area in 1985 and 1986 and found that the population had increased to an estimated 627 sheep in 1985 and 802 in 1986, indicating a period of rapid population growth.

This population was surveyed again in 1991 and 1997 (Nagy and Carey 2013a, Nagy and Carey 2013b). Three blocks (Bell, Millen, and White) were not surveyed in the Yukon in 1997. As a result, Nagy and Carey 2013b summarized the 1984, 1985, 1986 and 1991 data for the blocks surveyed in 1997. These data indicate that the population had continued to increased between 1991 and 1997, but the annual rate of growth had declined. The lamb to nursery sheep ratios were indicative of stable to increasing populations in 1991 and 1997. The number of full curl rams in the population increased dramatically from 50 in 1986 to 120 and 136 in 1991 and 1997, respectively.

In June 2001 we surveyed the study area established in 1984 (Barichello et al. 1987. There were three primary objectives of this survey:

1. Obtain current estimates of the numbers of lambs, nursery sheep, and rams (half, three-quarter, and full curl) in the populations.
2. Document the distribution of rams in the population during mid to late summer.
3. Obtain information that is required to determine the number and distribution of hunting permits within management zones allowable if limited entry sport hunts occur in the future.

This survey was conducted by ENR, Inuvik, NT, in cooperation with the GRRB, Inuvik, NT and the Department of Environment, Dawson, YT.

Study Area

The northern Richardson Mountains (67°30' to 68°30' N, 135°30' to 137° W) are in the "Northern Mountains and Coastal Plain" ecological region (Oswald and Senyk 1977) also called the Cordillera ecological region in the NWT (ECG 2010) (Figure 1). The central portion of the area is characterized by sharp ridges, rocky slopes and deep V-shaped valleys, and surrounded by gently rolling terrain. Most of the study area is over 1,500 m above sea level and is composed primarily of sedimentary rock. Permafrost is

continuous, temperatures average -9°C annually, and precipitation is about 500 mm (Barichello et al. 1987).

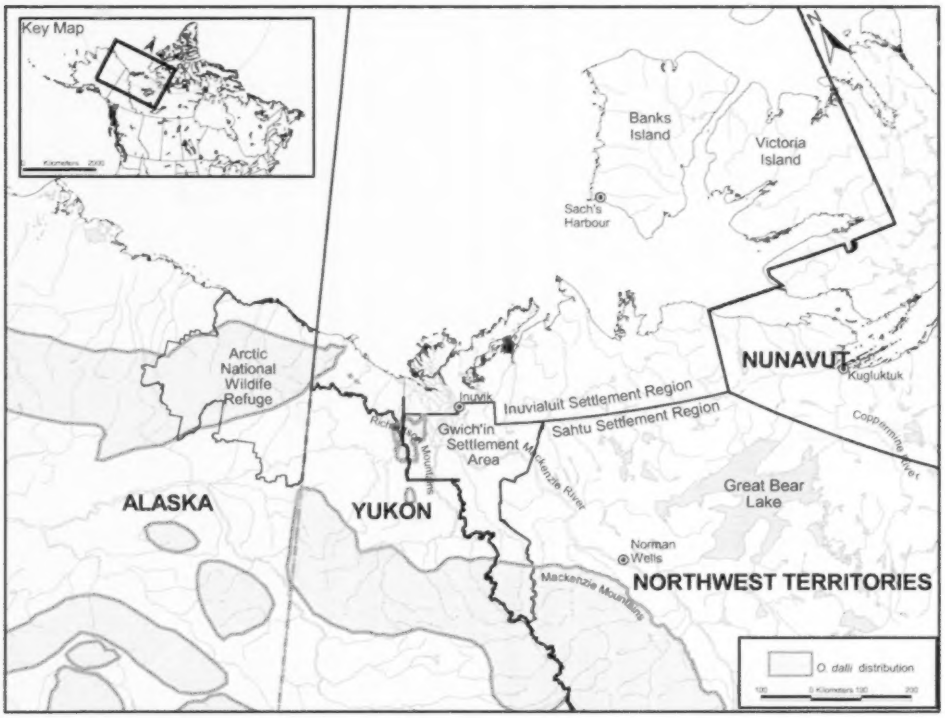

Figure 1. Location of the northern Richardson Mountains Dall's sheep study area (Oswald and Senyk 1977).

The study area is approximately 3,000 km^2 (Figure 2). Black spruce (*Picea mariana*) and balsam poplar (*Populus balsamifera*) occur in protected valleys. Tussock tundra (*Carex* spp. and *Eriophorum* spp.) dominates valley bottoms to mid-slopes (Barichello et al. 1987). Alpine vegetation dominates ridge tops at higher elevations. Barichello et al. (1987) suggested that 50% of the area could be considered potential sheep habitat with most of this occurring above the tree line where forage and escape terrain are available.

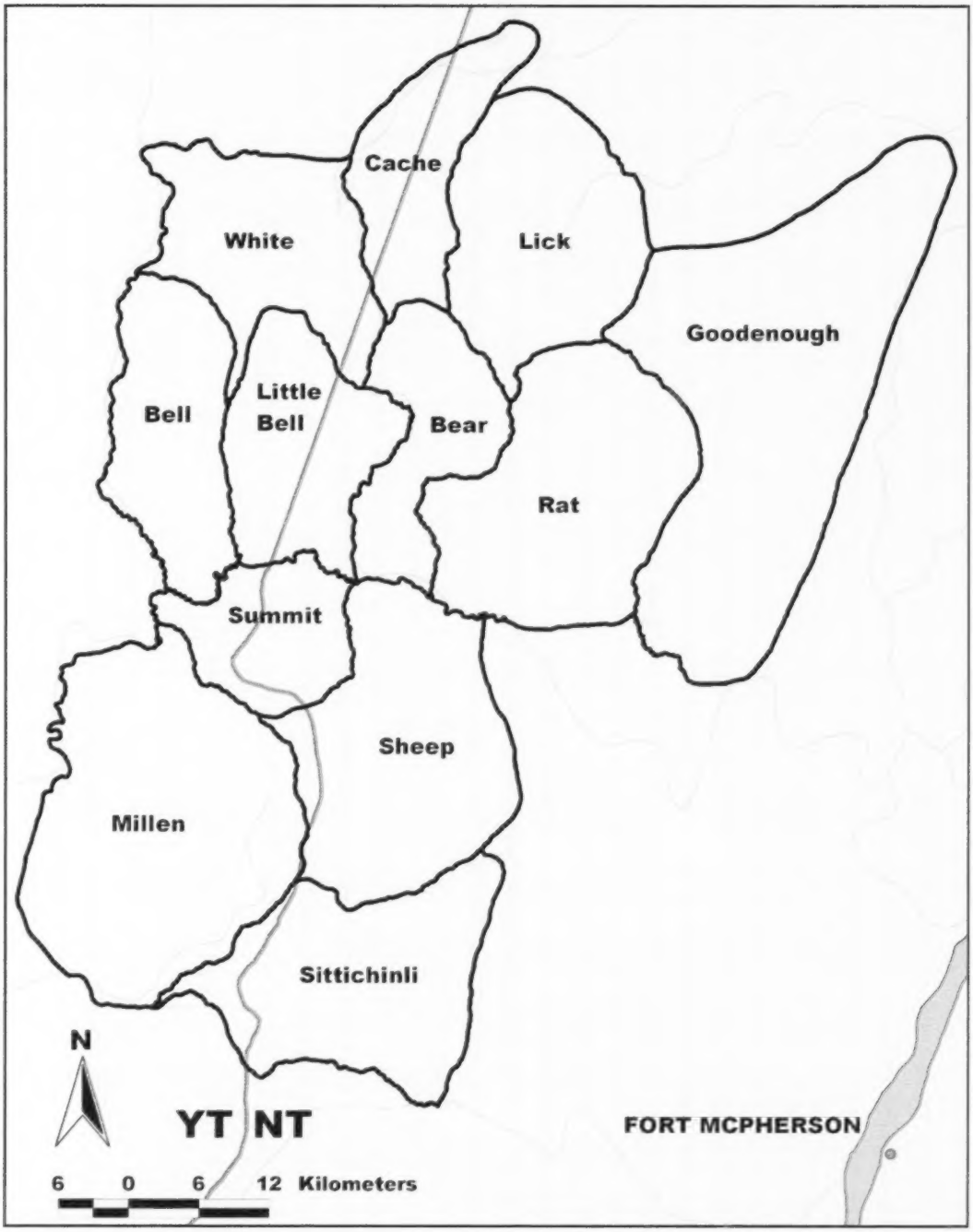

Figure 2. Blocks surveyed in the northern Richardson Mountains, June 2001.

Moose (*Alces americanus*) occur in low numbers throughout the eastern portion of the study area but are generally found along valley bottoms. The Porcupine caribou

herd (*Rangifer tarandus granti*) migrates through the area during spring and autumn (Porcupine Caribou Technical Committee 1993). In some years a portion of this herd summers and winters in the area. A few muskoxen (*Ovibos moschatus*) have been observed.

METHODS

The study area was subdivided into mountain blocks to facilitate a systematic survey and analysis of survey data (Figure 2). Complete coverage was obtained by contouring mountain blocks and river drainages using a helicopter flying at approximately 100 km/h and 200 m above ground. Sheep were counted and classified by sex and age class as follows: nursery sheep (ewes, yearlings, and two-year-old rams), lambs, and rams (half, three-quarter, and full curl). Nursery groups were classified as yearlings, young rams, and ewes whenever possible. The number of sheep in each group and sightings of other wildlife including grizzly bears (*Ursus arctos*), golden eagles (*Aquila chrysaetos*), wolves (*Canis lupus*), caribou (*Rangier tarandus*), moose (*Alces americanus*), and muskoxen (*Ovibos moschatus*) were recorded. A GPS was used to record the longitude and latitude coordinates of each sighting and the tracks flown.

The number of lambs, nursery sheep, rams (half, three-quarter, and full curl), lambs per 100 nursery sheep, and rams (half, three-quarter, and full curl) per 100 nursery sheep was calculated for each block and for the population. These data were summarized as follows:

- for years when all blocks were surveyed (1984, 1985, 1986, 1991, and 2001); and
- for the blocks surveyed in 1997 (Cache, Lick, Goodenough, Bear, Little Bell, Summit, Rat, Sheep, and Sittichinli) for each year (1984,1985, 1986, 1991, 1997, and 2001).

The finite rate of population change was estimated as follows (Caughley 1980):

$$\log_e e^r = r.$$

The distribution of lambs, nursery sheep, rams, and all sheep in the study area was mapped in ArcView 3.2 (Environmental Systems Research Institute).

RESULTS

The survey was flown during the period 20 to 25 June 2001. The lines flown during the survey are shown in Figure 3. Weather conditions were clear and bright while the survey was conducted (Table 1). Appendices A through D provide details on all sheep, grizzly bears, caribou, and golden eagles observed during the survey.

Table 1. Summary of activities and weather conditions during survey.

Date	Time	Area	Activity	Weather Conditions
20 June 2001	19:03 – 21:45	Mount Goodenough and portions of Lick and Rat	Survey	Clear and bright
21 June 2001			Weathered out	Low overcast, light snow flurries, rain
22 June 2001	13:29 – 17:41	Mount Goodenough	Fecal collection	Low overcast, light snow flurries
	22:03 – 00:07	Mount Goodenough and portions of Rat	Survey	Clear and bright
23 June 2001	07:47 – 12:30	Rat	Survey and fecal collection	Clear and bright
	14:21 – 19:10	Little Bell	Survey and fecal collection	Clear and bright
24 June 2001	07:40 – 12:14	Bell and White	Survey and fecal collection	Clear and bright
	13:11 – 16:25	White and Bear	Survey	Clear and bright
	18:55 – 21:23	Cache and Lick	Survey	Clear and bright
25 June 2001	08:48 – 11:21	Mount Millen and Sitichinli	Survey	Clear and bright
	11:59 – 15:19	Sheep, Summit, and Sitichinli	Survey	Clear and bright
	16:11 – 17:31	Sitichinli	Survey	Clear and bright

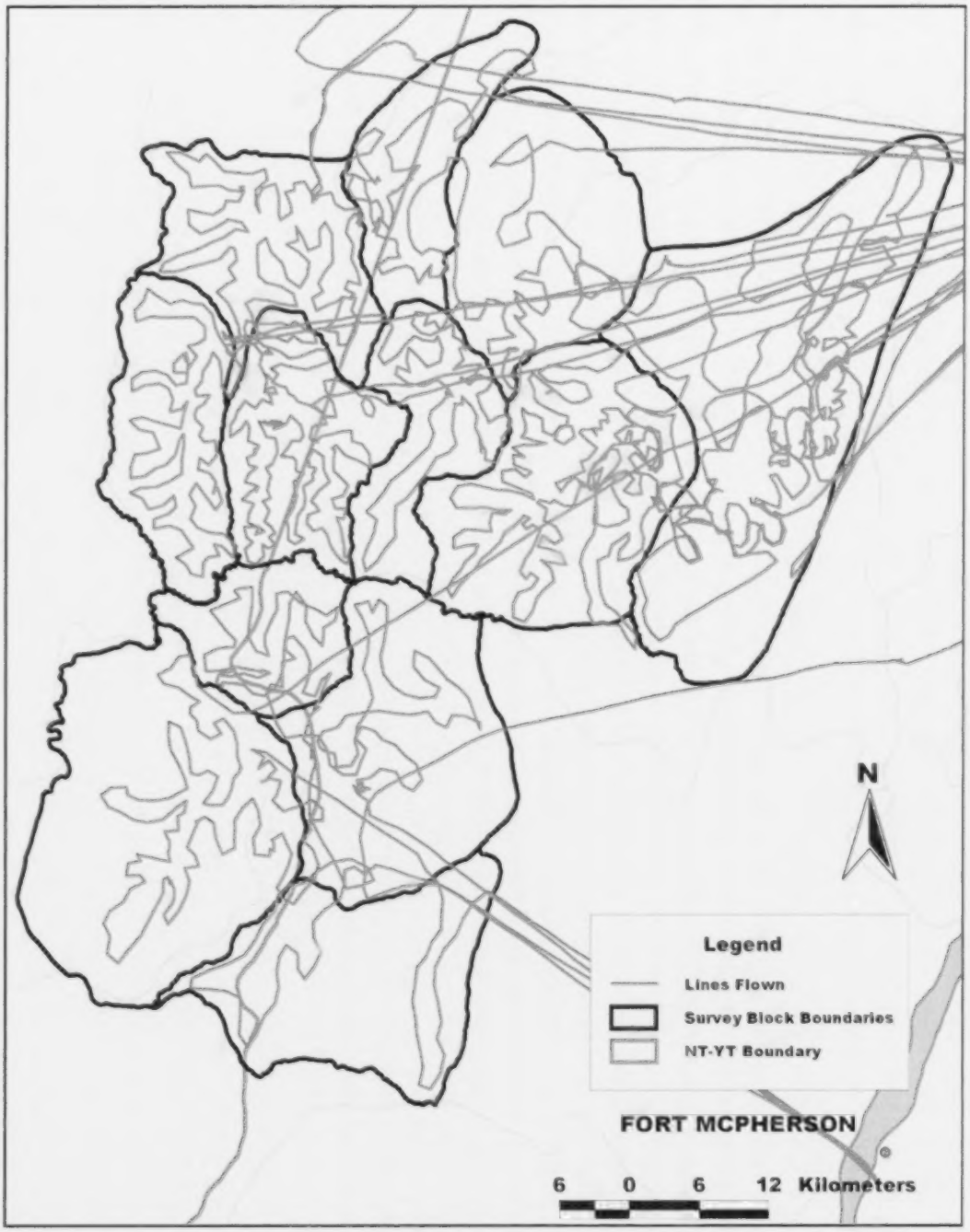

Figure 3. Lines flown during the northern Richardson Mountains Dall's sheep survey, June 2001.

Population Size and Trend

A total of 1,057 sheep were counted and classified in the study area including 734 nursery sheep, 92 lambs, 231 rams (43 half curl, 55 three-quarter curl and 133 full curl) (Table 2). The population declined from 1,344 sheep to 890 in the blocks the 1997 study area (Figure 4 and Table 4). This represents an annual finite rate of decline of 8% (Figure 5) and is the first decline documented for sheep in the Richardson Mountains study area since monitoring began in 1984.

Table 2. Classification of Dall's sheep by survey block in the northern Richardson Mountains, June 2001.

Survey Block	Nursery Sheep	Lambs	Rams				Total Sheep
			Half Curl	Three-quarter Curl	Full Curl	Total	
Bear	19	0	0	1	4	5	24
Bell	2	0	1	2	14	17	19
Cache	80	10	0	0	0	0	90
Goodenough	214	20	25	22	23	70	304
Lick	80	8	0	0	2	2	90
Little Bell	54	6	4	8	29	41	101
Millen	46	12	3	3	10	16	74
Rat	56	11	4	1	21	26	93
Sheep	112	14	5	16	8	29	155
Summit	22	2	0	0	9	9	33
White	49	9	1	2	13	16	74
Sittichinli	-	-	-	-	-	-	-
Total	**734**	**92**	**43**	**55**	**133**	**231**	**1,057**

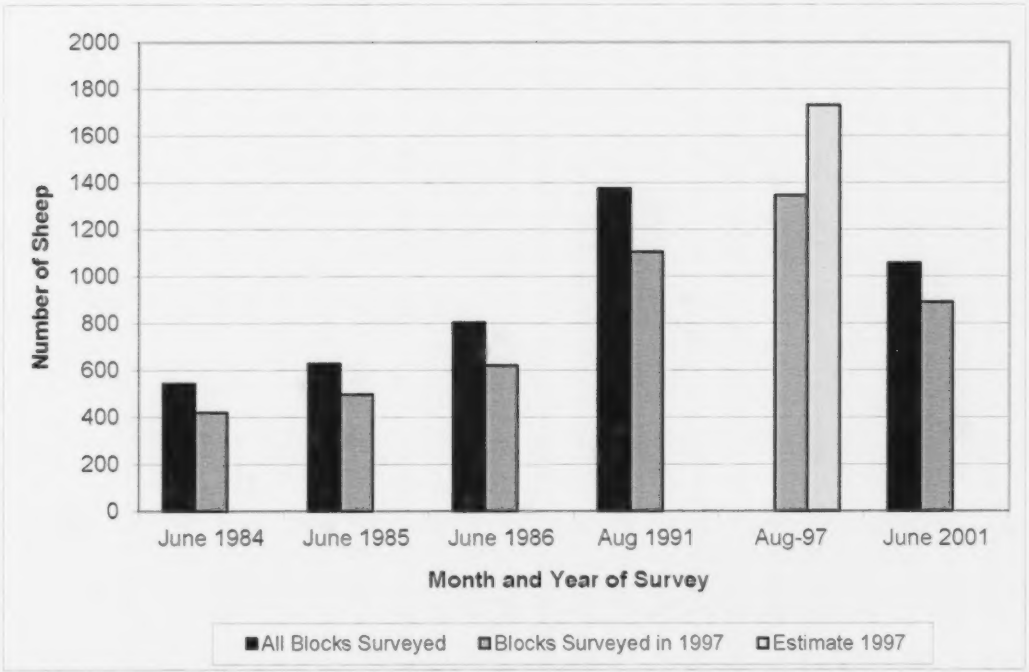

Figure 4. The number of Dall's sheep in the Richardson Mountains population during surveys conducted during the period 1984 to 2001.

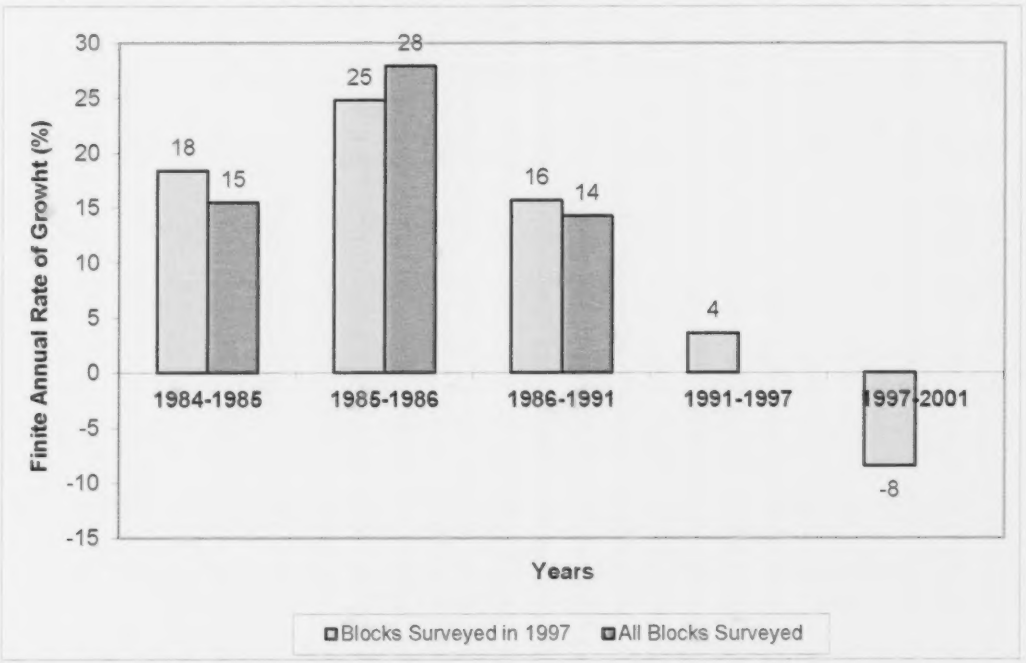

Figure 5. Finite annual rate of population growth for the Dall's sheep population in the Richardson Mountains during the period 1984 to 2001 (rates are based on changes in the number of sheep in the Cache, Lick, Goodenough, Bear, Little Bell, Summit, Rat, Sheep, and Sittichinli blocks only).

Productivity and Recruitment

The observed overall productivity of 12.5 lambs per 100 nursery sheep is low (Table 3). This value is noticeably lower than the 31.2 to 42.8 lambs per 100 nursery sheep reported during the period 1984 to 1997 (Table 4 and 5, Figure 6). Given that the 2001 lamb to nursery sheep ratio was documented in June, little recruitment can be expected during spring 2002. Further declines in the population can be expected.

Table 3. Demographic characteristics of Dall's sheep by survey block and the northern Richardson Mountains study area, June 2001.

Survey Block	Lambs per 100 Nursery Sheep	Total Non-lamb Sheep	Percentage Full Curl Rams of Total Rams	Rams per 100 Nursery Sheep
Bear	0.0	24	80	26.3
Bell	0.0	19	82	850.0
Cache	12.5	80		0.0
Goodenough	9.3	284	33	32.7
Lick	10.0	82	100	2.5
Little Bell	11.1	95	71	75.9
Millen	26.1	62	63	34.8
Rat	19.6	82	81	46.4
Sheep	12.5	141	28	25.9
Summit	9.1	31	100	40.9
White	18.4	65	81	32.7
Total	**12.5**	**965**	**58**	**31.5**

Table 4. Demographic characteristics of the Dall's sheep population during years when all survey blocks were flown.

Year[1]	No. by Class			All Sheep	No. per 100 Nursery Sheep		Percentage of Rams		
	Lambs	Nursery	Rams		Lambs	Rams	Half Curl	Three-quarter Curl	Full Curl
1984[2]	110	302	131	543	36.4	43.4	36.6	25.2	37.4
1985[2]	117	362	148	627	32.3	40.9	31.1	33.1	34.5
1986[2]	145	460	197	802	31.5	42.8	39.6	25.4	34.0
1991[3]	289	675	373	1,374	42.8	55.3	26.5	24.7	48.8
2001	92	734	231	1,057	12.5	31.5	18.6	23.8	57.6

[1] The Bell, Millen, and White blocks were not surveyed in 1997. As a result the 1997 data were not included in this table.
[2] Barichello et al. 1987.
[3] Nagy and Carey 2013a.

Table 5. Demographic characteristics of Dall's sheep in the Richardson Mountains summarized for only those blocks that were surveyed in 1997.

Year[1]	No. by Class			All Sheep	No. 100 Nursery Sheep		Percentage of Rams		
	Lamb	Nurse	Rams		Lambs	Rams	Half Curl	Three-quarter Curl	Full Curl
1984[2]	87	232	100	419	37.5	43.1	38.0	26.0	35.0
1985[2]	100	295	101	496	33.9	34.2	23.8	34.7	39.6
1986[2]	111	371	137	619	29.9	36.9	35.8	26.3	36.5
1991[3]	246	561	260	1,104	43.9	46.3	27.3	26.5	46.2
1997[4]	250	802	286	1,344	31.2	35.7	26.6	25.9	47.6
2001	71	637	182	890	11.1	28.6	20.9	26.4	52.7

[1] Cache, Lick, Goodenough, Bear, Little Bell, Summit, Rat, Sheep, and Sittichinli blocks were surveyed in 1997.
[2] Barichello et al. 1987
[3] Nagy and Carey 2013a.
[4] Nagy and Carey 2013b.

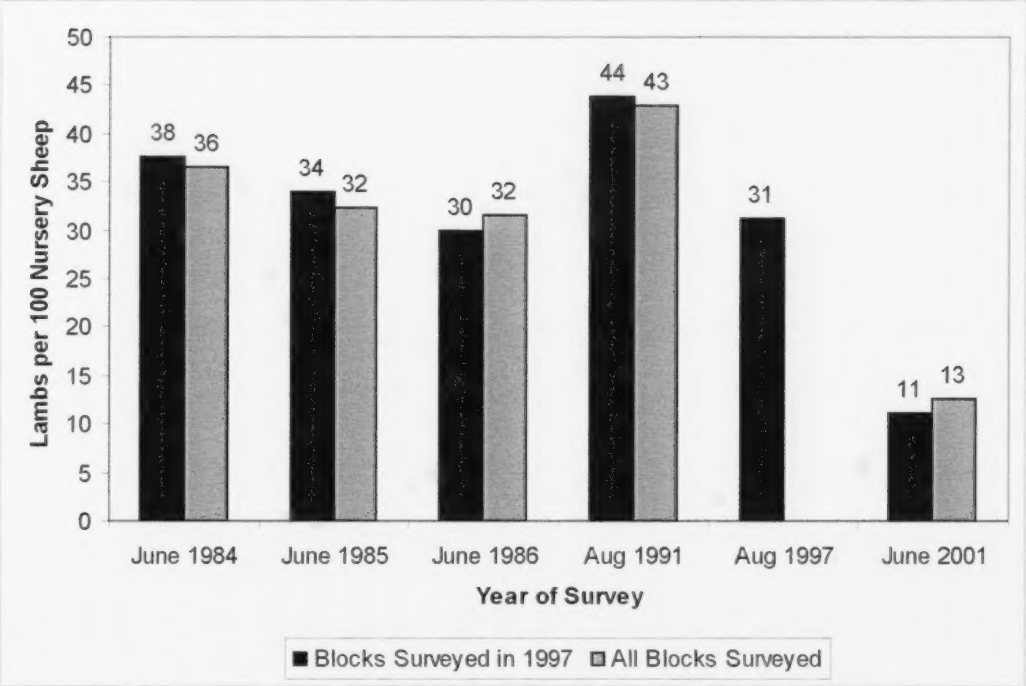

Figure 6. Number of lambs per 100 nursery sheep in the Richardson Mountains Dall's sheep population, 1984 to 2001.

The number of rams in the population declined from 373 in 1991 to 231 in 2001 (Table 4). Similarly the number of half and three-quarter curl rams declined during this period (Figure 7 and 8). The number of half curl rams in the population has declined from approximately 31.1% to 39.6% of the rams during 1984 to 1986 to less than 20% of the rams in 2001 (Table 4). In comparison the proportion of full curl rams increased from 34.0% to 37.4% of the rams during 1984 to 1986 to 57.6% in 2001. Given the low number of lambs and relatively low number of half and three-quarter curl rams in the population in 2001, recruitment to the full curl ram class can be expected to be low during the next few years. As a result, the number of half, three-quarter, and full curl rams can be expected to decline over the next few years.

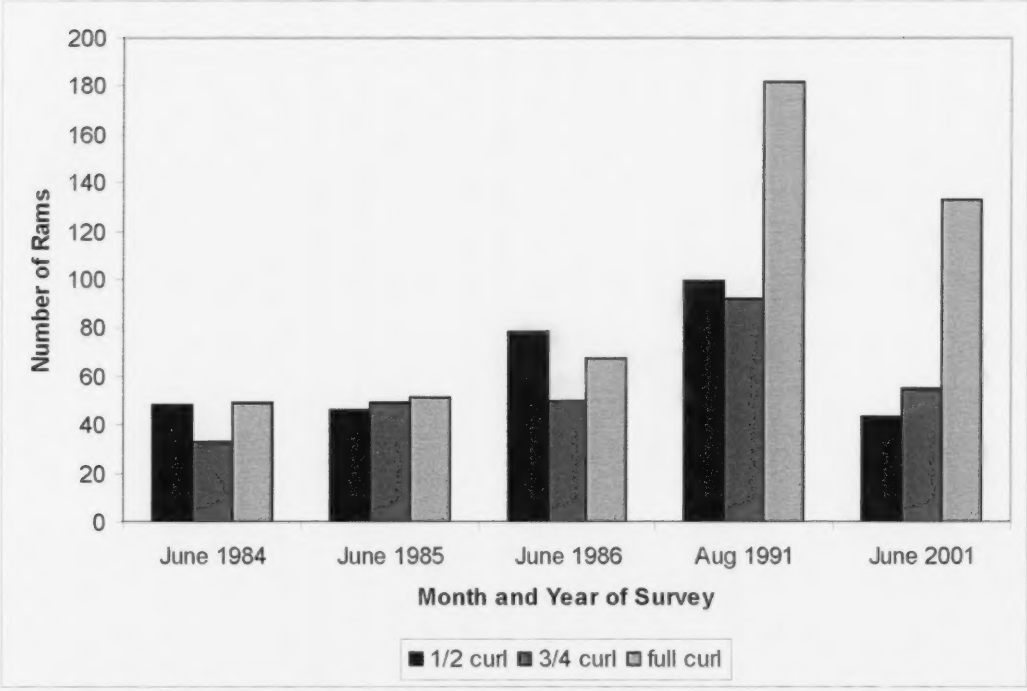

Figure 7. Number of half, three-quarter, and full curl rams in the Richardson Mountains population during years when all survey blocks were flown.

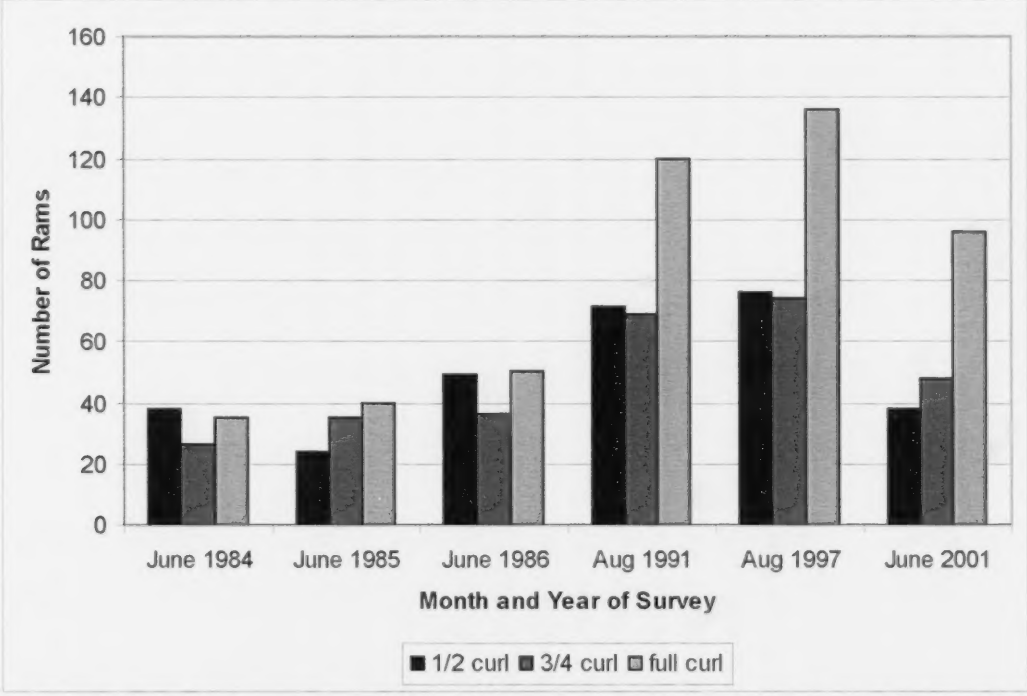

Figure 8. Number of half, three-quarter, and full curl rams in the Richardson Mountains population for blocks that were surveyed during 1997 flown.

Distribution of Lambs, Nursery Sheep, and Rams

The sites where we located lambs, nursery sheep, and rams in the Richardson Mountains during the survey are shown in Figures 9 through 12.

The proportions of the lambs and nursery sheep and half, three-quarter, and full curl rams found in each block surveyed during June 1984, 1985, 1986, and 2001 are given in Figure 13 through 17. The June distribution of sheep in the Richardson Mountains appears to be more distinct than in August. The majority of lambs and nursery sheep are found in the Goodenough, Sheep, and Cache blocks at this time of year (Figures 13 and 14). In 2001, 50% of the half curl rams were in the Goodenough block. However, they appeared to disperse through all blocks from 1984 to 1986 (Figure 15). Most of the three-quarter curl rams were in the Goodenough and Sheep blocks and they were essentially absent in the Cache and Lick blocks (Figure 16). Similarly, full curl rams were most consistently found in the Goodenough, Rat, and Sheep blocks in June, but were essentially absent from the Cache and Lick blocks (Figure 17).

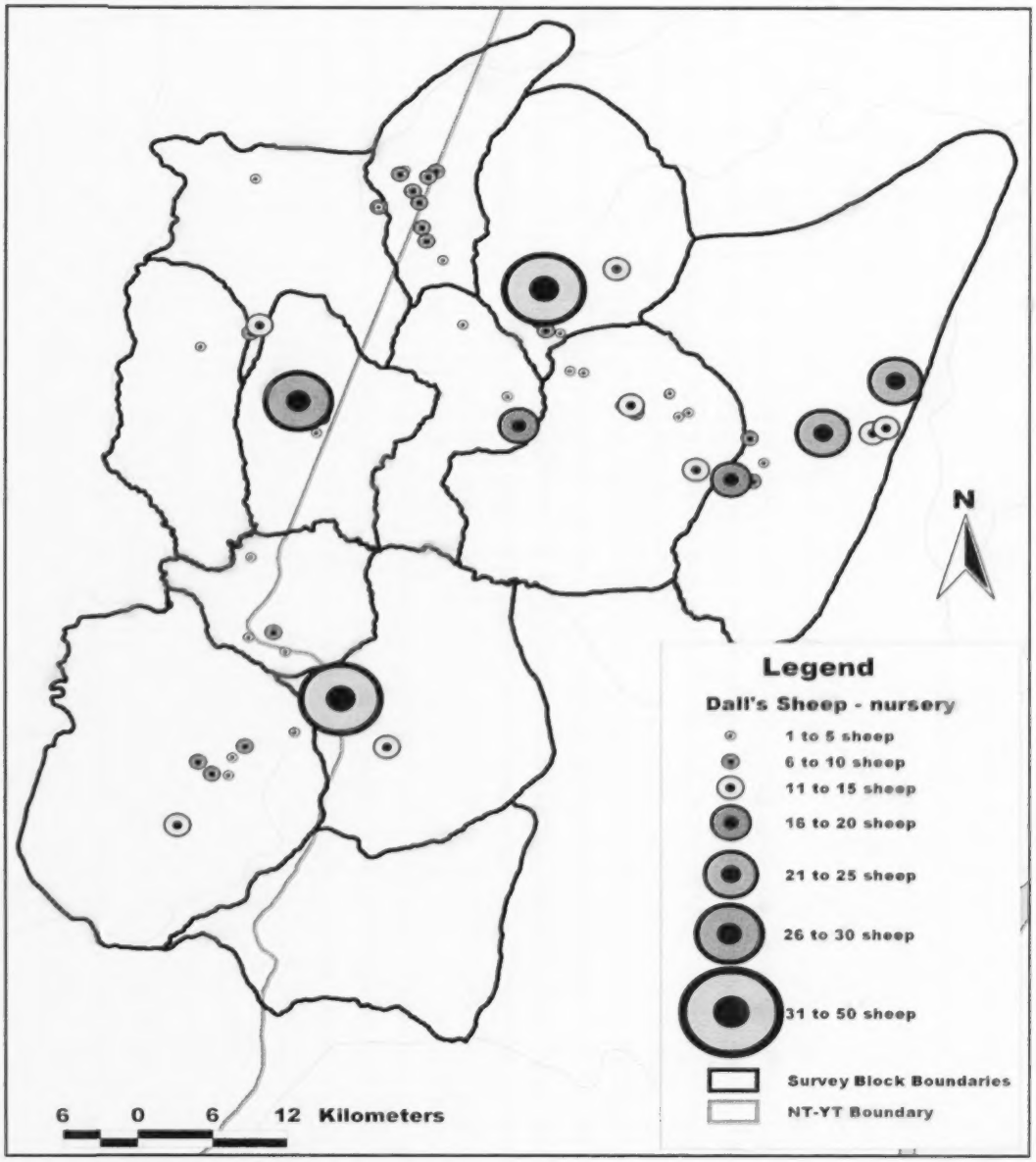

Figure 9. Distribution of nursery Dall's sheep in the northern Richardson Mountains, June 2001.

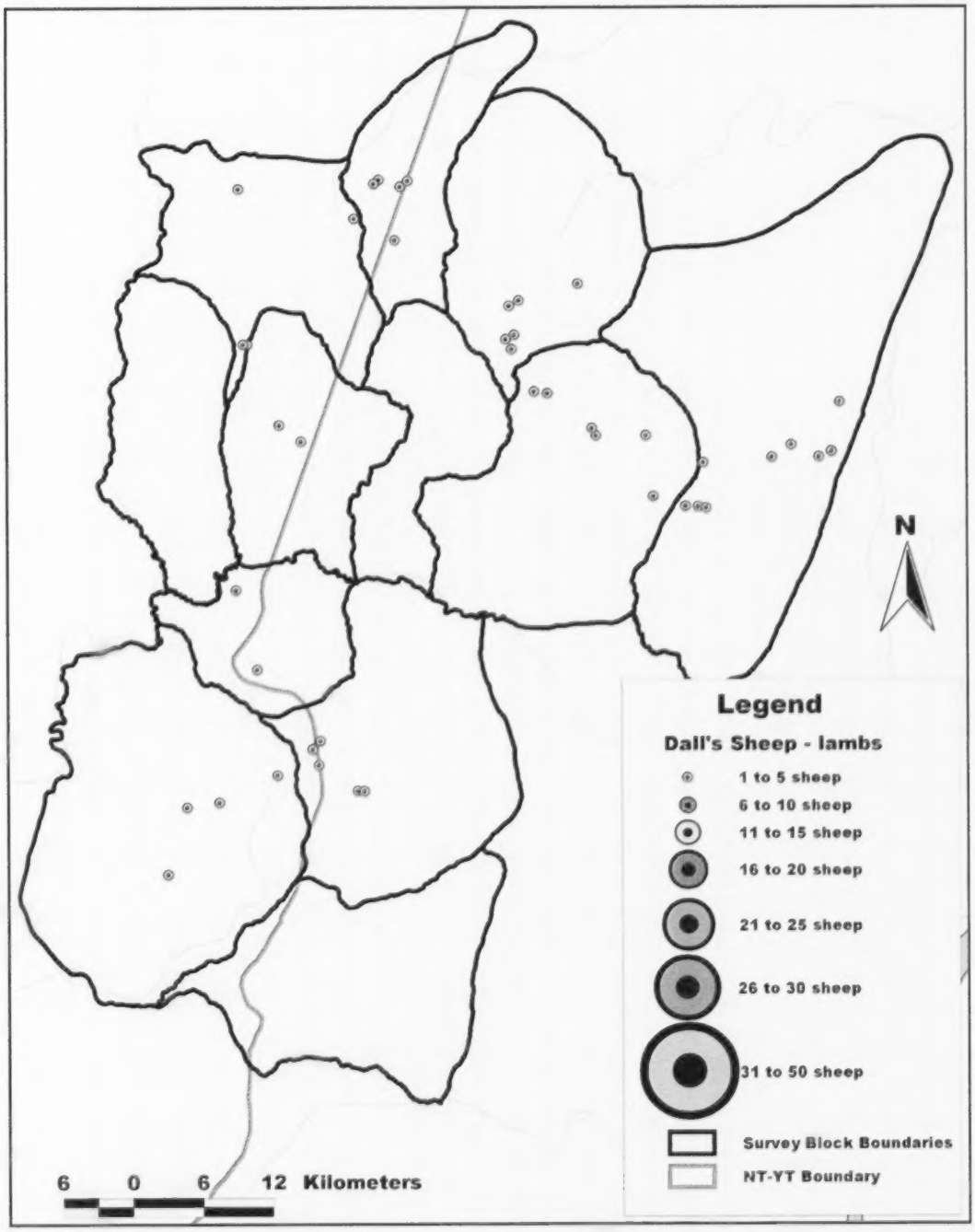

Figure 10. Distribution of Dall's sheep lamb in the northern Richardson Mountains, June 2001.

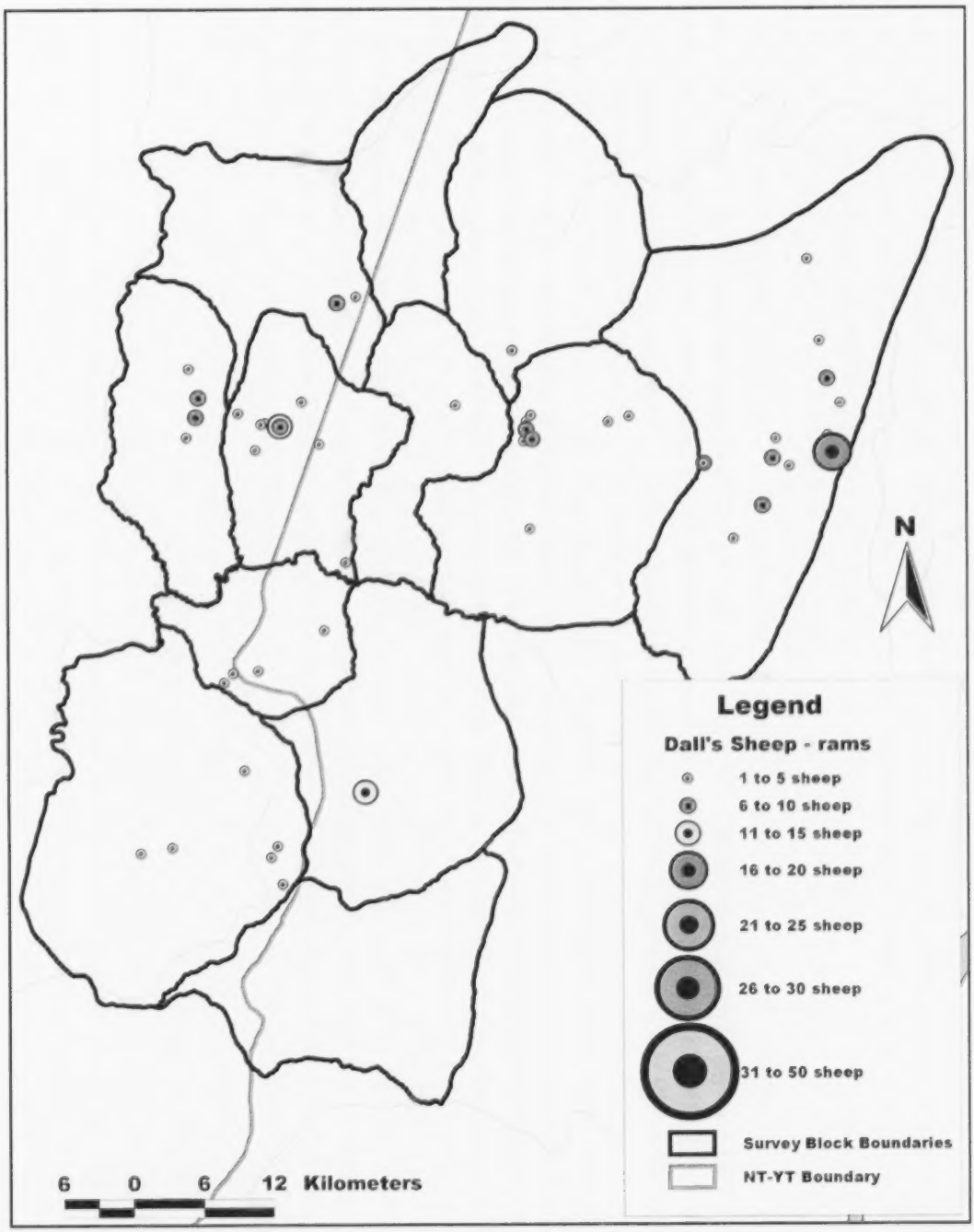

Figure 11. Distribution of Dall's sheep ram (half, three-quarter, and full curl) in the northern Richardson Mountains, June 2001.

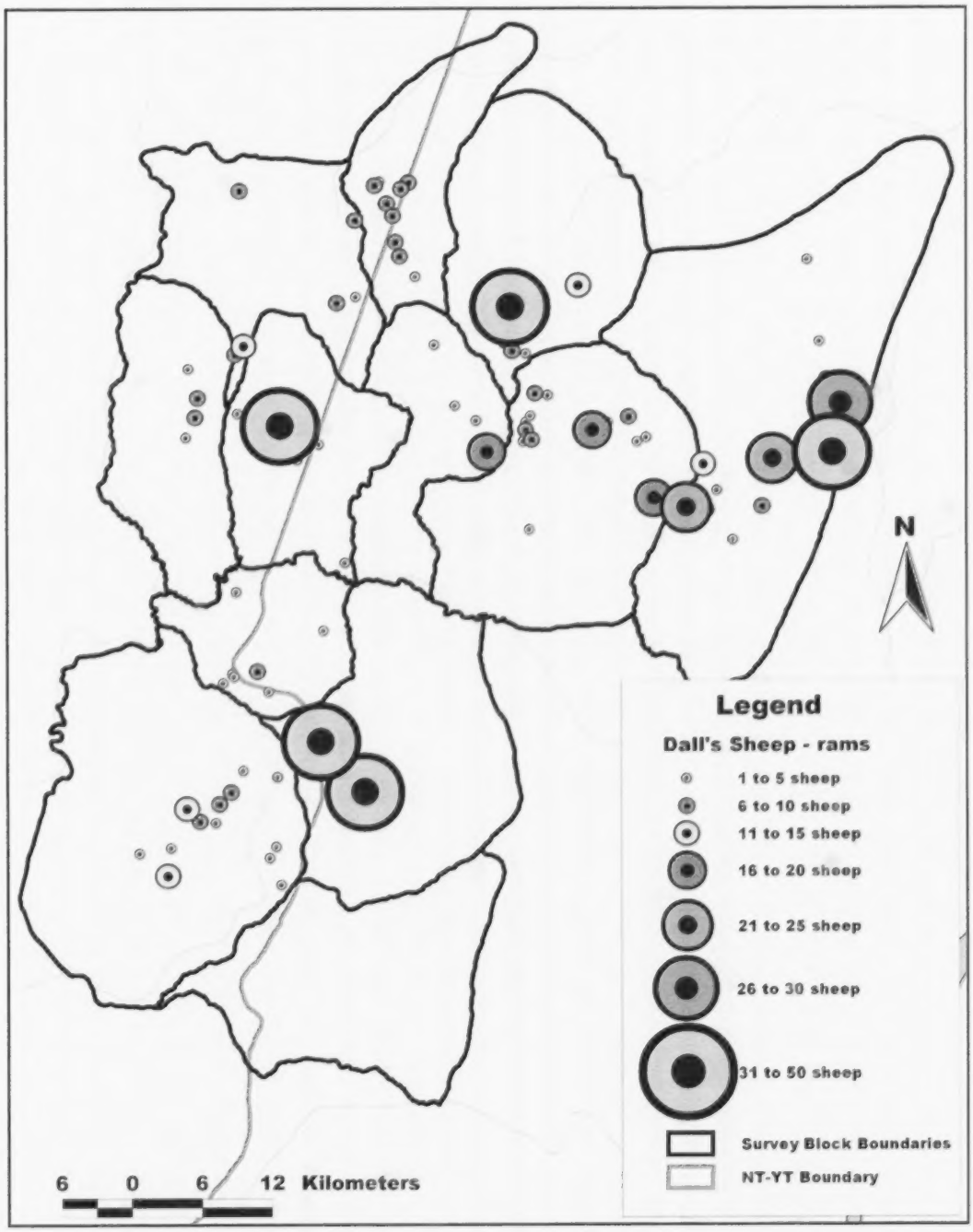

Figure 12. Distribution of Dall's sheep (nursery, lambs, and rams) in the northern Richardson Mountains, June 2001.

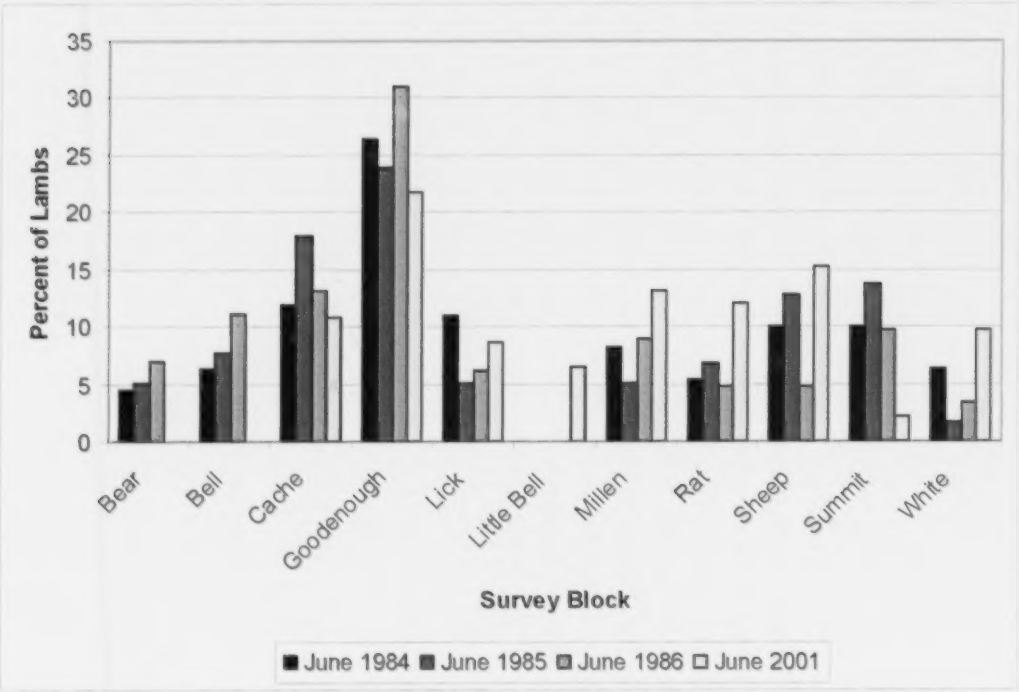

Figure 13. Percentage of the total number of lambs found in each blocks surveyed during June 1984, 1985, 1986, and 2001.

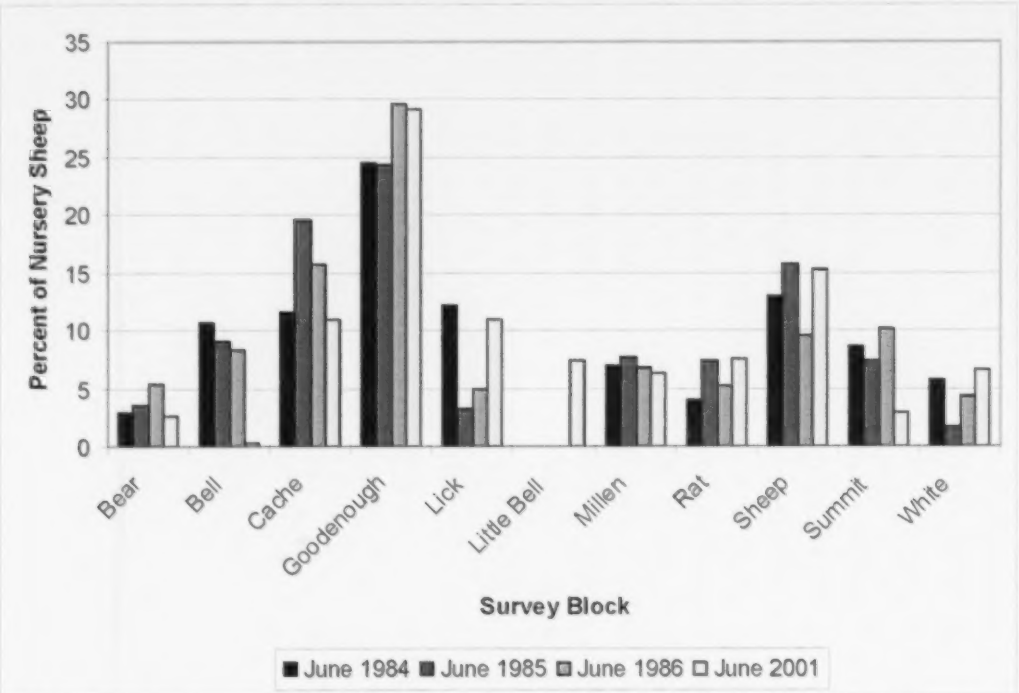

Figure 14. Percentage of the total number of nursery sheep found in each blocks surveyed during June 1984, 1985, 1986, and 2001.

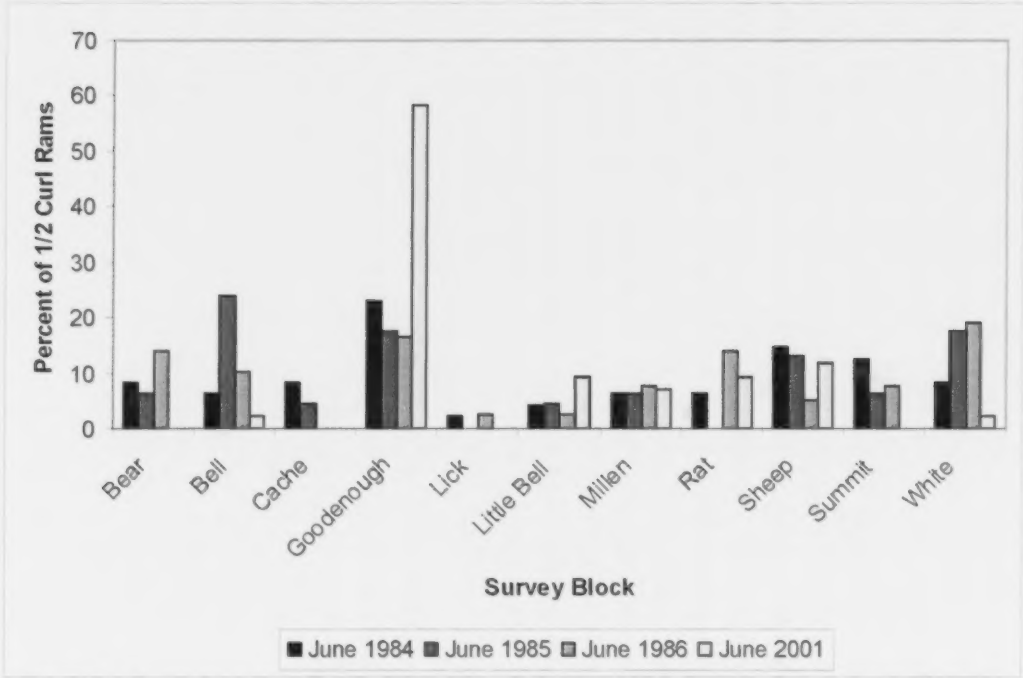

Figure 15. Percentage of the total number of half curl rams found in each blocks surveyed during June 1984, 1985, 1986, and 2001.

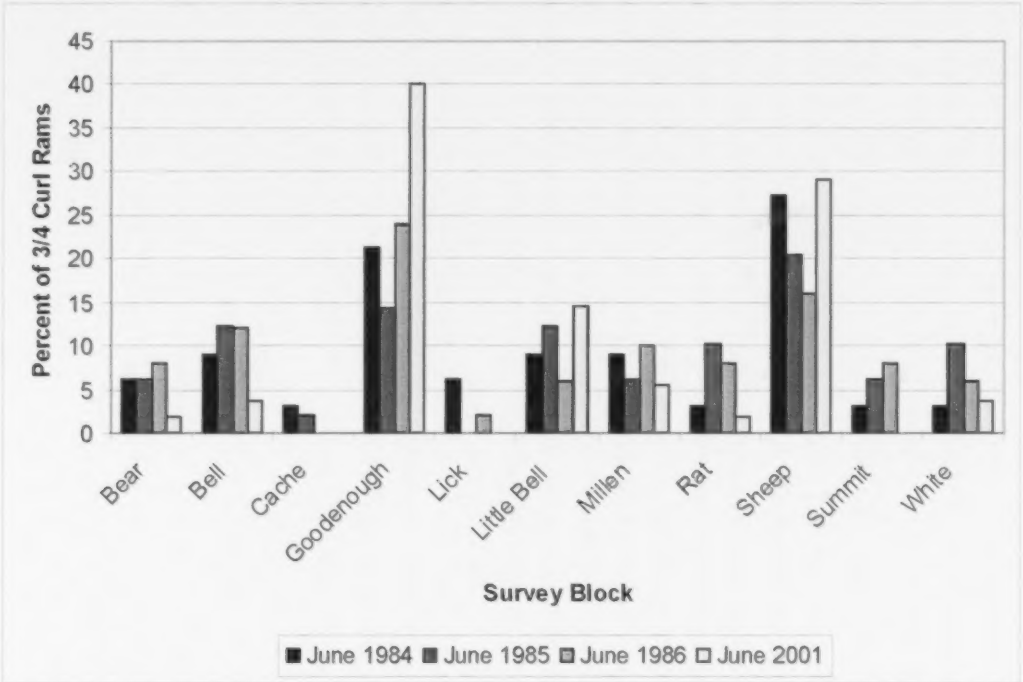

Figure 16. Percentage of the total number of three-quarter curl rams found in each blocks surveyed during June 1984, 1985, 1986, and 2001.

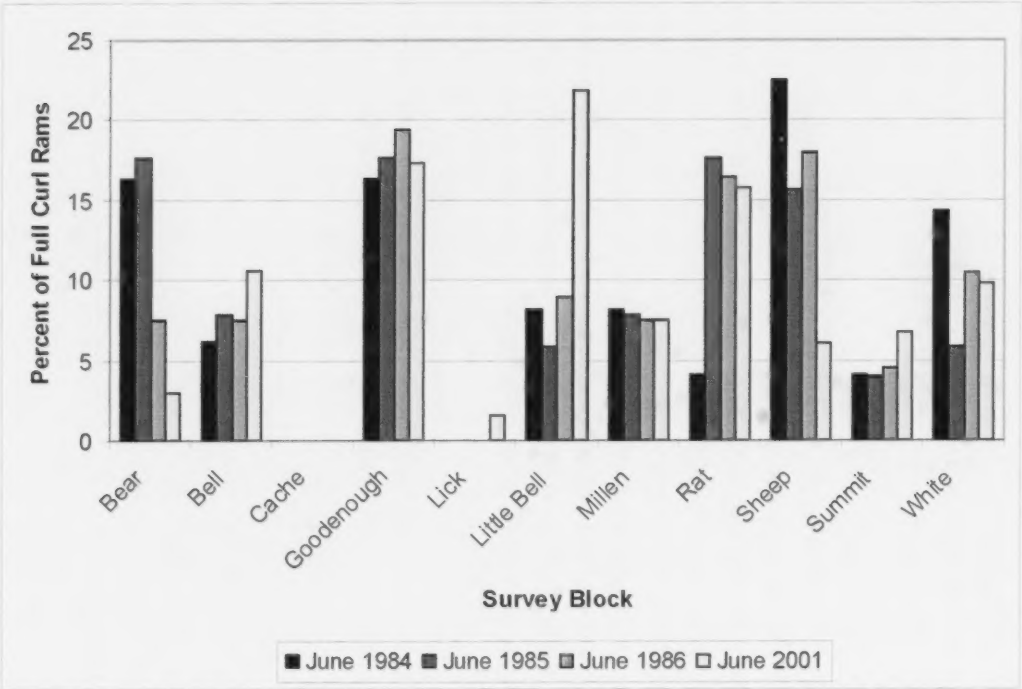

Figure 17. Percentage of the total number of full curl rams found in each blocks surveyed during June 1984, 1985, 1986, and 2001.

The majority of the nursery (68%), lambs (56%), half curl rams (79%), three-quarter curl (75%), and full curl rams (53%) were found within the NWT (Table 5). A total of 696 of the 1,061 (66%) sheep observed during the survey were found in the NWT. This is consistent with observations made in 1991 (Table 6).

The distribution and numbers of caribou, grizzly bears and golden eagles observed during that survey are shown in Figures 18 to 20.

Table 6. Number of Dall's sheep by class in the NT and YT, August 2003.

Year[1]	Class of Sheep	NWT		YT		Total
		No.	Percentage	No.	Percentage	
1991[2]	Nursery	494	73	184	27	678
	Lambs	215	75	71	25	286
	Half curl ram	65	66	34	34	99
	Three-quarter curl ram	58	63	34	37	92
	Full curl ram	95	52	87	48	182
	Total	**927**	**70**	**410**	**30**	**1337**
1997[3]	Nursery	746	93	56	7	802
	Lambs	226	90	24	10	250
	Half curl ram	70	92	6	8	76
	Three-quarter curl ram	71	96	3	4	74
	Full curl ram	122	90	14	10	136
	Total	**1235**	**92**	**103**	**8**	**1338**
2001	Nursery	498	68	238	32	736
	Lambs	53	56	41	44	94
	Half curl ram	34	79	9	21	43
	Three-quarter curl ram	41	75	14	25	55
	Full curl ram	70	53	63	47	133
	Total	**696**	**66**	**365**	**34**	**1,061**

[1] The Bell, Millen, and White blocks were not surveyed in 1997. All blocks were surveyed in 1991, 2001, and 2003.
[2] Nagy and Carey 2013a
[3] Nagy and Carey 2013b

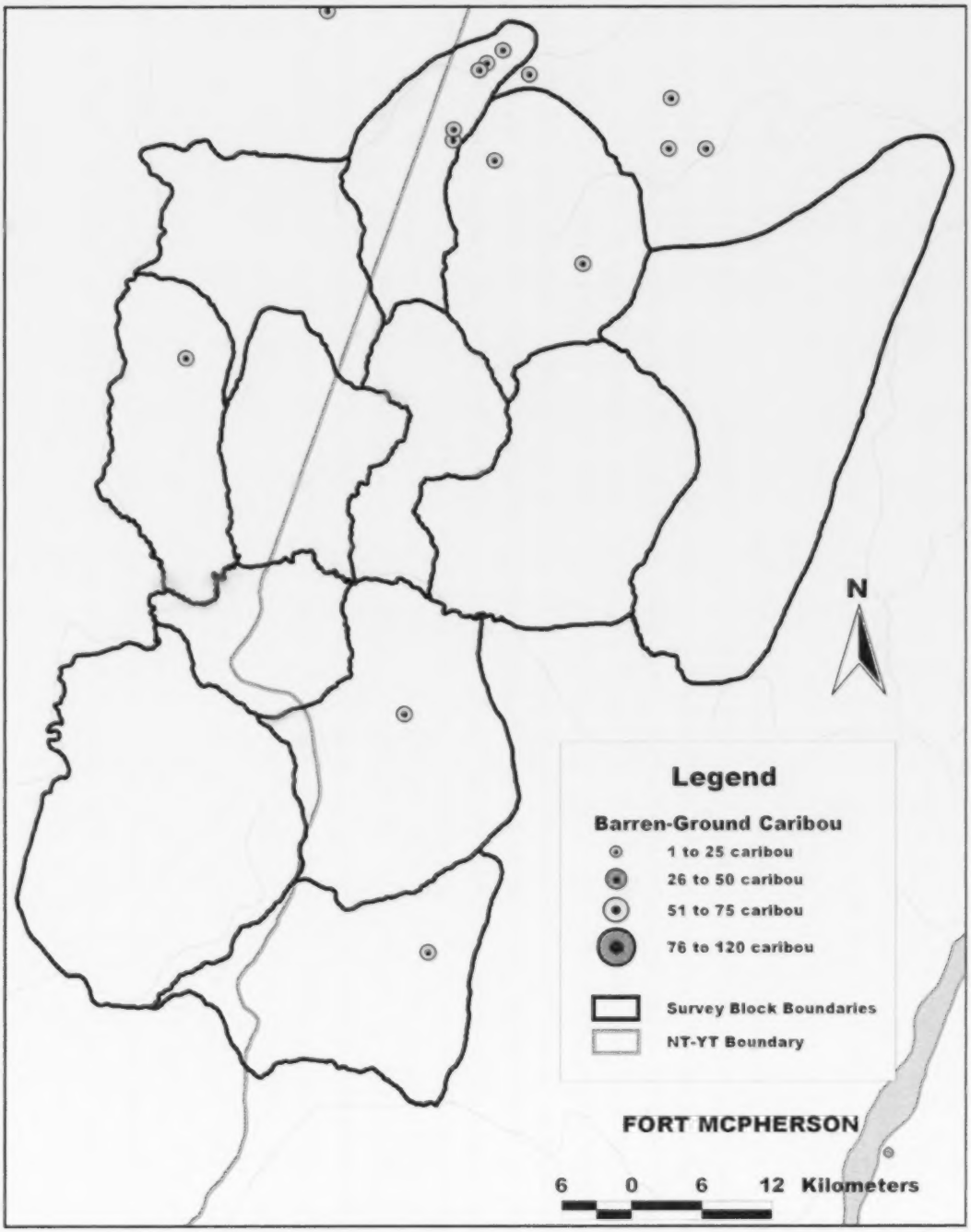

Figure 18. Distribution of caribou in the northern Richardson Mountains, June 2001.

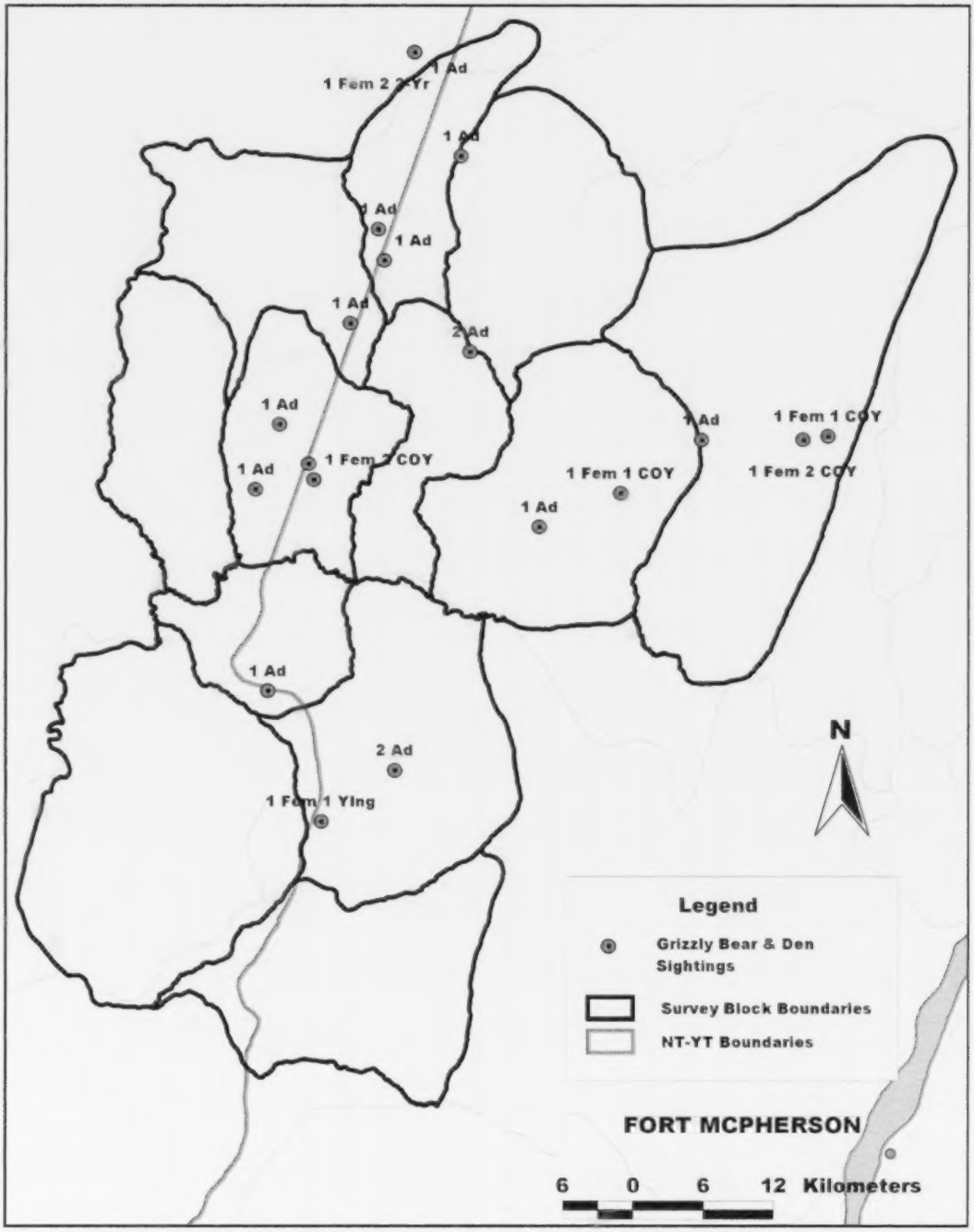

Figure 19. Distribution of grizzly bears in the northern Richardson Mountains, June 2001.

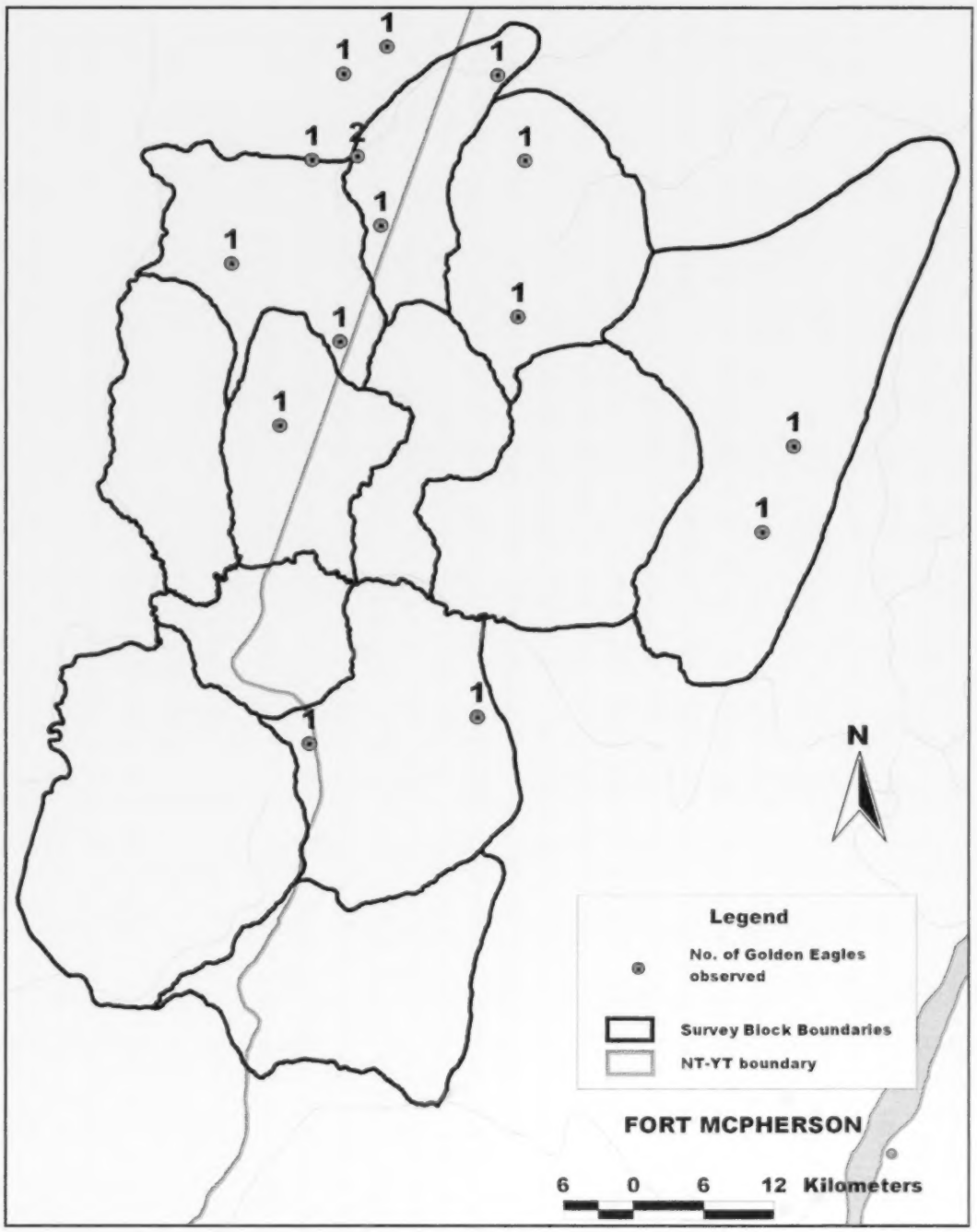

Figure 20. Distribution of golden eagle sightings in the northern Richardson Mountains, June 2001.

DISCUSSION

The Dall's sheep population increased from 543 in 1984 to approximately 1,730 in 1997. The results of the 2001 Richardson Mountains Dall's sheep survey indicate that this population declined between 1997 and 2001. This is the first decline documented for the Richardson Mountain population since 1984. The number of lambs per 100 nursery sheep in June was the lowest ever documented for this population indicating either low productivity or low survival of lambs. The rate of 12.5 lambs per 100 nursery sheep is indicative of a declining population. The number of rams in the population declined dramatically between 1997 and 2001. The low numbers of lambs, half curl, and three-quarter curl rams suggest that recruitment to the full curl class will be relatively low over the next few years. As a result, the number of full curl rams in the population can be expected to decline over the next few years. The June distribution of most three-quarter and full curl rams during 2001 appears to be consistent with that observed during 1984, 1985, and 1986.

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APPENDIX A. Classification of Dall's sheep by survey block and sighting in the northern Richardson Mountains, June 2001.

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					Total Sheep
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	
Bear	187	67.92	-136.28	1	0	0	0	0	0	1
Bear	188	67.88	-136.20	0	0	0	1	4	5	5
Bear	189	67.88	-136.14	2	0	0	0	0	0	2
Bear	190	67.86	-136.10	16	0	0	0	0	0	16
Bell	146	67.84	-136.73	2	0	1	0	0	1	3
Bell	148	67.79	-136.69	0	0	0	0	1	1	1
Bell	149	67.81	-136.69	0	0	0	2	4	6	6
Bell	150	67.82	-136.69	0	0	0	0	9	9	9
Cache	204	68.04	-136.44	6	0	0	0	0	0	6
Cache	205	68.04	-136.44	1	1	0	0	0	0	2
Cache	206	68.04	-136.44	3	0	0	0	0	0	3
Cache	207	68.03	-136.45	7	2	0	0	0	0	9
Cache	208	68.03	-136.45	3	1	0	0	0	0	4
Cache	209	68.03	-136.45	1	0	0	0	0	0	1
Cache	210	68.03	-136.45	2	1	0	0	0	0	3
Cache	211	68.03	-136.45	2	0	0	0	0	0	2
Cache	212	68.03	-136.45	1	0	0	0	0	0	1
Cache	213	68.02	-136.46	9	0	0	0	0	0	9
Cache	214	68.02	-136.46	5	0	0	0	0	0	5
Cache	215	68.02	-136.46	2	0	0	0	0	0	2
Cache	216	68.01	-136.44	9	0	0	0	0	0	9
Cache	218	68.03	-136.50	6	2	0	0	0	0	8
Cache	219	68.03	-136.49	3	1	0	0	0	0	4
Cache	222	67.99	-136.42	8	2	0	0	0	0	10
Cache	223	67.98	-136.40	6	0	0	0	0	0	6

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					Total Sheep
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	
Cache	226	67.97	-136.36	3	0	0	0	0	0	3
Cache	227	67.97	-136.36	1	0	0	0	0	0	1
Goodenough	2	68.02	-135.53	0	0	0	0	4	4	4
Goodenough	4	68.08	-135.61	0	0	0	0	3	3	3
Goodenough	46	67.99	-135.49	0	0	4	2	0	6	6
Goodenough	47	67.90	-135.68	0	0	2	0	0	2	2
Goodenough	48	67.90	-135.68	0	0	4	2	0	6	6
Goodenough	49	67.90	-135.68	6	0	1	0	0	1	7
Goodenough	50	67.90	-135.68	10	1	0	0	0	0	11
Goodenough	51	67.88	-135.63	2	0	0	0	0	0	2
Goodenough	52	67.87	-135.64	8	1	0	0	0	0	9
Goodenough	53	67.87	-135.66	6	1	0	0	0	0	7
Goodenough	54	67.86	-135.68	19	2	0	0	0	0	21
Goodenough	57	67.85	-135.57	0	0	0	0	3	3	3
Goodenough	59	67.88	-135.54	0	0	2	0	4	6	6
Goodenough	60	67.92	-135.55	9	3	0	0	0	0	12
Goodenough	61	67.92	-135.55	1	0	0	0	0	0	1
Goodenough	62	67.92	-135.55	8	0	3	3	0	6	14
Goodenough	63	67.92	-135.55	25	0	0	0	0	0	25
Goodenough	64	67.92	-135.51	0	0	3	0	0	3	3
Goodenough	65	67.92	-135.54	3	0	0	0	0	0	3
Goodenough	66	67.94	-135.55	0	0	3	2	0	5	5
Goodenough	67	67.93	-135.52	2	1	0	0	0	0	3
Goodenough	70	67.93	-135.46	15	1	0	0	0	0	16
Goodenough	71	67.94	-135.44	3	0	0	0	0	0	3
Goodenough	72	67.94	-135.44	3	0	0	0	0	0	3
Goodenough	73	67.94	-135.44	0	0	1	1	0	2	2
Goodenough	74	67.95	-135.46	0	0	0	1	0	1	1
Goodenough	76	67.94	-135.44	14	0	1	9	9	19	33

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					Total Sheep
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	
Goodenough	77	67.94	-135.44	13	1	0	0	0	0	14
Goodenough	78	67.94	-135.44	3	0	0	0	0	0	3
Goodenough	79	67.94	-135.44	5	0	0	0	0	0	5
Goodenough	80	67.94	-135.44	5	0	0	0	0	0	5
Goodenough	81	67.94	-135.44	8	1	0	0	0	0	9
Goodenough	82	67.94	-135.44	3	0	1	0	0	1	4
Goodenough	83	67.94	-135.44	2	1	0	0	0	0	3
Goodenough	84	67.94	-135.44	2	2	0	0	0	0	4
Goodenough	85	67.94	-135.44	1	1	0	0	0	0	2
Goodenough	86	67.94	-135.44	12	1	0	0	0	0	13
Goodenough	87	67.96	-135.46	3	0	0	0	0	0	3
Goodenough	88	67.98	-135.45	23	3	0	2	0	2	28
Lick	229	67.97	-136.16	31	3	0	0	0	0	34
Lick	230	67.95	-136.13	1	1	0	0	0	0	2
Lick	231	67.94	-136.14	6	1	0	0	0	0	7
Lick	232	67.94	-136.12	7	0	0	0	1	1	8
Lick	233	67.94	-136.12	7	1	0	0	0	0	8
Lick	234	67.94	-136.12	2	0	0	0	0	0	2
Lick	235	67.94	-136.12	4	0	0	0	0	0	4
Lick	236	67.94	-136.12	1	0	0	0	1	1	2
Lick	237	67.94	-136.09	2	0	0	0	0	0	2
Lick	239	67.96	-136.13	7	0	0	0	0	0	7
Lick	240	67.98	-136.14	1	1	0	0	0	0	2
Lick	241	68.00	-136.04	11	1	0	0	0	0	12
Little Bell	118	67.85	-136.49	0	0	0	0	1	1	1
Little Bell	119	67.88	-136.63	9	1	0	0	0	0	10
Little Bell	120	67.82	-136.61	0	0	0	0	3	3	3
Little Bell	121	67.80	-136.55	0	0	0	0	3	3	3
Little Bell	123	67.82	-136.56	0	0	0	0	2	2	2

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					Total Sheep
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	
Little Bell	124	67.82	-136.55	1	0	0	0	1	1	2
Little Bell	125	67.82	-136.52	1	0	2	5	4	11	12
Little Bell	126	67.82	-136.52	0	0	0	2	0	2	2
Little Bell	127	67.82	-136.52	5	2	0	0	0	0	7
Little Bell	128	67.82	-136.52	0	0	1	0	0	1	1
Little Bell	129	67.82	-136.52	0	0	0	0	1	1	1
Little Bell	130	67.82	-136.52	30	2	1	0	9	10	42
Little Bell	135	67.82	-136.46	6	1	0	0	0	0	7
Little Bell	136	67.80	-136.46	2	0	0	0	0	0	2
Little Bell	139	67.74	-136.30	0	0	0	1	3	4	4
Little Bell	140	67.82	-136.43	0	0	0	0	2	2	2
Mt Millen	252	67.56	-136.36	0	0	0	0	1	1	1
Mt Millen	253	67.54	-136.37	6	1	0	0	0	0	7
Mt Millen	254	67.53	-136.38	5	1	0	0	0	0	6
Mt Millen	255	67.52	-136.44	8	3	0	0	0	0	11
Mt Millen	256	67.48	-136.44	0	0	0	0	1	1	1
Mt Millen	257	67.47	-136.50	0	0	0	0	3	3	3
Mt Millen	258	67.46	-136.43	2	0	0	0	0	0	2
Mt Millen	259	67.46	-136.43	3	1	0	0	0	0	4
Mt Millen	260	67.46	-136.43	11	4	0	0	0	0	15
Mt Millen	261	67.51	-136.41	6	1	0	0	0	0	7
Mt Millen	262	67.51	-136.37	1	0	0	0	0	0	1
Mt Millen	263	67.50	-136.25	0	0	0	0	3	3	3
Mt Millen	264	67.51	-136.24	0	0	2	1	0	3	3
Mt Millen	265	67.48	-136.21	0	0	1	2	2	5	5
Mt Millen	267	67.56	-136.29	3	1	0	0	0	0	4
Mt Millen	268	67.56	-136.29	1	0	0	0	0	0	1
Rat	6	67.92	-135.85	5	0	1	0	0	1	6
Rat	7	67.92	-135.85	1	0	0	0	0	0	1

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	Total Sheep
Rat	55	67.86	-135.75	15	2	0	0	0	0	17
Rat	56	67.86	-135.75	3	0	0	0	0	0	3
Rat	91	67.91	-136.02	1	1	0	0	0	0	2
Rat	92	67.91	-136.05	4	0	0	0	0	0	4
Rat	93	67.91	-136.05	5	2	0	0	0	0	7
Rat	94	67.89	-136.04	0	0	0	0	3	3	3
Rat	95	67.89	-136.05	0	0	2	0	0	2	2
Rat	96	67.88	-136.04	0	0	0	0	6	6	6
Rat	97	67.87	-136.04	0	0	0	0	4	4	4
Rat	98	67.88	-136.03	0	0	0	0	6	6	6
Rat	100	67.81	-135.97	0	0	0	0	1	1	1
Rat	102	67.90	-135.93	1	0	0	0	0	0	1
Rat	103	67.90	-135.91	13	3	0	0	0	0	16
Rat	104	67.89	-135.90	6	2	0	0	0	0	8
Rat	105	67.91	-135.89	0	0	1	1	1	3	3
Rat	106	67.90	-135.82	1	0	0	0	0	0	1
Rat	107	67.91	-135.81	1	1	0	0	0	0	2
Sheep	277	67.57	-136.13	2	1	0	2	0	2	5
Sheep	278	67.57	-136.11	1	0	0	0	0	0	1
Sheep	279	67.57	-136.11	0	0	4	0	2	6	6
Sheep	280	67.57	-136.11	5	1	0	0	6	6	12
Sheep	281	67.57	-136.11	3	1	0	0	0	0	4
Sheep	282	67.57	-136.11	11	0	1	0	0	1	12
Sheep	283	67.57	-136.11	14	4	0	14	0	14	32
Sheep	285	67.60	-136.23	46	1	0	0	0	0	47
Sheep	301	67.59	-136.24	4	1	0	0	0	0	5
Sheep	302	67.59	-136.24	13	1	0	0	0	0	14
Sheep	303	67.59	-136.24	11	2	0	0	0	0	13
Sheep	304	67.58	-136.22	2	2	0	0	0	0	4

Survey Block	Sighting	Latitude	Longitude	Nursery Sheep	Total					Total Sheep
					Lambs	Half Curl	Three-quarter Curl	Full Curl	Total	
Summit	288	67.62	-136.36	3	0	0	0	0	0	3
Summit	290	67.68	-136.30	0	0	0	0	3	3	3
Summit	291	67.69	-136.49	2	1	0	0	0	0	3
Summit	292	67.64	-136.40	2	0	0	0	4	4	6
Summit	293	67.64	-136.40	10	0	0	0	0	0	10
Summit	294	67.64	-136.40	3	1	0	0	0	0	4
Summit	295	67.63	-136.44	2	0	0	0	0	0	2
Summit	296	67.63	-136.44	0	0	0	0	1	1	1
Summit	297	67.62	-136.45	0	0	0	0	1	1	1
White	152	67.87	-136.65	6	0	0	0	0	0	6
White	153	67.87	-136.64	3	2	0	0	0	0	5
White	154	67.87	-136.64	14	1	0	0	0	0	15
White	155	67.93	-136.49	0	0	1	1	5	7	7
White	156	67.93	-136.49	0	0	0	1	7	8	8
White	158	67.94	-136.46	0	0	0	0	1	1	1
White	159	68.00	-136.51	6	0	0	0	0	0	6
White	160	68.00	-136.51	5	1	0	0	0	0	6
White	161	68.00	-136.51	3	1	0	0	0	0	4
White	181	67.99	-136.76	4	2	0	0	0	0	6
White	182	67.99	-136.76	2	0	0	0	0	0	2
White	183	67.99	-136.76	5	2	0	0	0	0	7
White	184	67.99	-136.76	1	0	0	0	0	0	1

APPENDIX B. Classification of grizzly bears observed in the northern Richardson Mountains, June 2001.

WPT	Lat	Long	Time	Adult	COY	Yearling	2-yr old	Total	comment
18	67.94	-135.50	6/22/01 23:31	1	2	0	0	3	1 Female with 2 cubs of year
22	67.95	-135.46	6/22/01 23:37	1	1	0	0	2	1 Female with 1 cub of year
11	67.81	-135.95	6/23/01 09:07	1	0	1	0	2	1 Adult (unknown sex)
19	67.86	-135.82	6/23/01 09:59	1	1	0	0	2	1 Female with 1 cub of year
2	67.92	-136.45	24/06/01 08:09	1	0	0	0	1	1 Adult (unknown)
24	68.13	-136.52	24/06/01 11:50	1	0	0	2	3	1 Fem with 2 2-year olds
24	68.13	-136.52	24/06/01 11:50	1	0	0	0	1	1 Adult (sex unknown)
14	67.92	-136.20	24/06/01 15:26	2	0	0	0	2	2 Adult (sex unknown)
17	67.99	-136.46	6/24/01 19:56	1	0	0	0	1	1 Adult (sex unknown)
20	67.97	-136.43	6/24/01 20:00	1	0	0	0	1	1 Adult (sex unknown)
22	68.07	-136.35	6/24/01 20:13	1	0	0	0	1	1 Adult (sex unknown)
7	67.77	-136.52	23/06/01 15:46	1	0	0	0	1	1 Adult (sex unknown)
10	67.82	-136.52	23/06/01 16:09	1	0	0	0	1	1 Adult (sex unknown)
15	67.79	-136.42	23/06/01 18:14	1	2	0	0	3	1 Fem 2 cubs of year
16	67.80	-136.44	23/06/01 18:17	1	0	1	0	2	1 Fem 1 yearling
2	67.92	-135.70	6/25/01 09:09	1	0	0	0	1	1 Adult (sex unknown)
16	67.54	-136.17	6/25/01 10:38	1	0	1	0	2	1 Fem 1 yearling
5	67.60	-136.07	6/25/01 12:31	2	0	0	0	2	2 Adult (sex unknown)
9	67.62	-136.36	6/25/01 13:09	1	0	0	0	1	1 Adult (sex unknown)

APPENDIX C. Classification of caribou observed in the northern Richardson Mountains, June 2001.

WPT	Lat	Long	Local Time	Adult	Calf
5	67.85	-136.74	24/06/01 08:26	1	1
26	68.16	-135.98	24/06/01 11:59	4	0
3	68.14	-136.71	24/06/01 13:39	5	0
4	68.19	-136.61	24/06/01 13:42	1	0
3	68.15	-136.27	6/24/01 19:18	1	0
4	68.16	-136.34	6/24/01 19:20	2	0
5	68.14	-136.36	6/24/01 19:20	1	0
6	68.14	-136.37	6/24/01 19:21	1	0
7	68.09	-136.38	6/24/01 19:23	9	0
8	68.08	-136.38	6/24/01 19:24	4	0
32	68.02	-136.04	6/24/01 20:51	3	0
36	68.12	-135.95	6/24/01 21:09	9	0
37	68.13	-135.88	6/24/01 21:10	1	0
20	67.47	-135.88	6/25/01 10:55	20	0
7	67.64	-136.08	6/25/01 12:43	1	0
33	68.07	-136.28	6/24/01 21:01	4	0

APPENDIX D. Classification of golden eagles observed in the northern Richardson Mountains, June 2001.

WPT	Lat	Long	Local Time	Adults
11	67.86	-135.52	6/22/01 23:04	1
17	67.93	-135.52	6/22/01 23:28	1
10	67.82	-136.52	23/06/01 16:09	1
13	67.90	-136.46	24/06/01 09:54	1
19	68.03	-136.64	24/06/01 11:14	1
20	68.10	-136.64	24/06/01 11:18	1
21	68.13	-136.57	24/06/01 11:20	1
25	68.14	-136.34	24/06/01 11:54	1
5	68.24	-136.54	24/06/01 13:45	1
8	67.93	-136.72	24/06/01 14:27	1
13	68.04	-136.56	6/24/01 19:45	2
28	67.96	-136.14	6/24/01 20:35	1
34	68.08	-136.23	6/24/01 21:03	1
8	67.66	-135.95	6/25/01 12:47	1
18	67.60	-136.25	6/25/01 14:30	1
16	68.00	-136.46	6/24/01 19:56	1